## Stormwater Management Manual 2.3.4: Eco-Roof

### Facility Description


**Eco-Roofs** are impervious area reduction techniques. Eco-Roofs are vegetated roof systems used in place of conventional roofs. Eco-roofs provide stormwater management by capturing, filtering, and, depending on the season, evapo-transpirates precipitation while providing aesthetic and energy conservation benefits.

Eco-Roofs meet the stormwater management standard for imperious area reduction techniques.


### Design Requirements

Sizing: Eco-Roofs replace impervious area at a 1:1 ratio. They are not allowed to receive water from other impervious areas.

Slope: Maximum roof slope shall be 25% unless the applicant can provide documentation for runoff control on steeper slopes.

Drain: As with a conventional roof, an Eco-Roof must safely drain runoff from the roof to an approved stormwater destination.

### Materials

Structural Roof Support: The structural roof support must be sufficient to hold the additional weight of the Eco-Roof. For retrofit projects, check with an architect, structural engineer, or roof consultant to determine the condition of the existing building structure and what might be needed to support an Eco-Roof. This might include additional decking, roof trusses, joists, columns, and/or foundations. Generally, the building structure must be adequate to hold an additional 10 to 25 pounds per square-foot (psf) saturated weight, depending on the vegetation and growth medium that will be used. (This is in addition to snow load requirements.) An existing rock ballast roof may be structurally sufficient to hold a 10-12 psf Eco-Roof. (Ballast typically weighs 10-12 psf.)

For New Construction: The project architects and structural engineers shall address the structural requirements of the Eco-Roof during the design process. Greater flexibility and options are available for new buildings than for re-roofing. The procedures for the remaining components are the same for both re-roofing and new construction.

Waterproof Membrane (Impermeable Material): Good quality waterproofing material must be used on the roof surface. Waterproof membranes are made of various materials, such as modified asphalts (bitumens), synthetic rubber (EPDM), hypolan (CPSE), and reinforced PVC. Some of the materials come in sheets or rolls and some are in liquid form. They have

different strengths and functional characteristics. Some of these products require root inhibitors and other materials to protect the membrane. Numerous companies manufacture waterproofing materials appropriate for Eco-Roofs.

Protection Boards or Materials: These materials protect the waterproof membrane from damage during construction and over the life of the system, usually made of soft fibrous materials.

Root Barrier (if needed): Root barriers are made of dense materials that inhibit root penetration. The need for a root barrier depends on the waterproof membrane selected. Modified asphalts usually require a root barrier, while synthetic rubber (EPDM) and reinforced PVC generally do not. Check with the manufacturer to determine if a root barrier is required for a particular product. Membranes impregnated with pesticides are not allowed. Manufacturers shall disclose the concentration of leach out for membranes impregnated with copper.

Drainage Layer (if needed): There are numerous ways to provide drainage. Products range from manufactured perforated plastic sheets to a thin layer of gravel. Some Eco-Roof designs do not require any drainage layer other than the growth medium itself, depending on roof slope and size (for example, pitched roofs and small flat roofs).

Gravel Ballast (if needed): Gravel ballast is sometimes placed along the perimeter of the roof and at air vents or other vertical elements. The need for ballast depends on operational and structural design issues. It is sometimes used to provide maintenance access, especially to vertical elements requiring periodic maintenance. In many cases, very little, if any, ballast is needed. In some situations a header or separation board may be placed between the gravel ballast and adjacent elements (such as soil or drains). If a root barrier is used, it must extend under the gravel ballast and growth medium, and up the side of the vertical elements.

**Vegetation**

Eco-Roof vegetation should have the following attributes:

- Drought-tolerant, requiring little or no irrigation after establishment
- Growth patterns that allow the plants to thoroughly cover the soil (at least 90% of the overall surface should be covered and maintained within 2 growing seasons)
- Self-sustaining, without the need for fertilizers, pesticides, or herbicides able to withstand heat, cold, and high winds
- Very low-maintenance, needing little or no mowing or trimming
- Perennial or self-sowing
- Fire resistant

A mix of sedum/succulent plant communities is recommended because they possess many of these attributes. Herbs, forbs, grasses, and other low groundcovers can also be used to provide additional benefits and aesthetics; however, these plants may need more watering and maintenance to survive and keep their appearance.

Four methods (or combinations of them) are generally used to install the vegetation: vegetation mats, plugs/ potted plants, sprigs, and seeds.

1. Vegetation mats are sod-like, pre-germinated mats that achieve immediate full plant coverage. They provide immediate erosion control, do not need mulch, and minimize weed intrusion. They also need minimal maintenance during the establishment period and little ongoing watering and weeding. Plugs or potted plants may provide more design flexibility than mats. However, they take longer to achieve full coverage, are more prone to erosion, need more watering during establishment, require mulching and more weeding.

2. Sprigs are hand-broadcast. They require more weeding, erosion control, and watering than mats.

3. Seeds can be either hand-broadcast or hydraseeded. Like sprigs, they require more weeding, erosion control, and watering than mats.

4. Soil coverage to prevent erosion shall be established immediately upon installation by using mulch, vegetation mats, or other approved protection method. Ninety-percent (90%) plant coverage should be achieved within 2 years. Temporary irrigation to establish plants is recommended. A permanent irrigation system using potable water may be used, but an alternative means of irrigation, such as air conditioning condensate or other non-potable sources, is recommended. Alternative sources should be analyzed to determine if the source has chemicals that might harm or kill the vegetation.

Growth Medium (Soil): The growth medium is generally 2 to 6-inches thick and well drained. It weighs from 10 to 25 pounds per square-foot when saturated. A simple mix of one-fourth topsoil, one-fourth compost, and one-half pumice perlite may be sufficient for most applications. Some companies have their own growth medium specifications. Other components may include digested fiber, expanded clay or shale, or coir.

### 4.5.2 Eco-Roof O & M Plan

**Eco-Roofs** are lightweight vegetated roof systems used in place of conventional roofs. Eco-Roofs provide stormwater management by capturing, filtering, and, depending on the season, evapo-transpirates 10 to 100 percent of the precipitation while providing aesthetic and energy conservation benefits.

All facility components, including the growth medium, vegetation, drains, membranes, and roof structure shall be inspected for proper operations, integrity of the waterproofing, and structural stability throughout the life of the Eco-Roof. All elements shall be inspected once a month from April through September.

**Aesthetics** of the Eco-Roof shall be maintained as an asset to the property owner and community. Evidence of damage or vandalism shall be repaired and accumulation of trash or debris shall be removed upon discovery.

**Training and/or Written Guidance** information for operating and maintaining Eco-Roofs shall be provided to all property owners and tenants. A copy of the O & M Plan shall be provided to all property owners and tenants.

**Inspection Logs** shall be kept by the facility owner demonstrating the following items have been inspected and are being maintained properly:

- **Access** to the Eco-Roof shall be safe and efficient. Walkways shall be clear of obstructions.
- **Debris and Litter** shall be removed to prevent clogging of drainage and damaging plant growth. Fallen leaves and debris from deciduous plant foliage shall be removed.
- **Growing Medium** shall be inspected for evidence of erosion from wind or water. If erosion channels are evident, they shall be stabilized with additional soil substrate/growth medium and covered with additional plants.
- **Structure Components** shall be operated and maintained in accordance with manufacturer's requirements. Drain inlets shall be kept unrestricted. Inlet pipe shall be cleared when sedimentation, vegetation, debris or other materials clog the drain inlet. Sources of sediment and debris shall be identified and corrected. Determine if drain inlet pipe is in good condition and correct as needed.
- **Vegetation** shall be maintained to provide 90% plant cover. During the Establishment Period, plants shall be replaced once per month as needed. During the long-term period, dead plants shall generally be removed and replaced once per year in the Fall months. Weeding shall be manual without the use of herbicides or pesticides. Weeds shall be removed regularly and not allowed to accumulate. Only non-chemical fertilizers may be used, if necessary. During drought conditions, mulch or shade cloth may be applied to prevent excess solar damage and water loss. Mowing of grasses shall occur as needed. Clippings shall be removed.

**Irrigation** can be accomplished either through hand watering or automatic sprinkler systems. If automatic sprinklers are used, manufacturer's instructions for operations and maintenance shall be followed.

- During the Establishment Period (2 years), water sufficiently to assure plant establishment and not to exceed ¼ inch of water once every 3 days shall be applied.
- During the long-term period (2+ years), water sufficiently to maintain plant cover and not to exceed ¼ inch of water once every 14 days shall be applied.

**Spill Prevention Measures** from mechanical systems located on Eco-Roofs shall be exercised when handling substances that can contaminate stormwater. Releases of pollutants shall be corrected as soon as identified.

**Non-Chemical Pest Control** measures shall be taken to prevent development of insects, mosquitoes, and rodents.